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Medical Evacuation, History and Development— The Future in the Multinational Environment

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SUMMARY:

This paper will present a brief overview of the history of casualty evacuation from the battlefield. The development of this essential part of military medical services will be reviewed, with particular emphasis upon the development of air evacuation. The future of casualty evacuation in the multinational environment of the new strategic situation will be discussed, along with NATO efforts to standardise various aspects of this modality of patient care.

DISCUSSION:

Since the dawn of warfare, clearing the wounded from the battlefield has been a persistent problem, and it remains so today.

In the earliest wars, there was no organised system for evacuating wounded from battlefields. In many wars, the slightly wounded were enslaved, and the seriously wounded were killed or left to die on the field. The only way a casualty got off the battlefield was under his own power, or with the aid of a comrade. Even the ancient Greeks and Romans, who had military surgeons and occasionally field hospitals attached to their forces, failed to provide any viable means of evacuation.

Historically, the advent of the first truly organised military medical systems which included evacuation capabilities was found in the army of the Byzantine Empire. *Scribonius*, stationed a hundred meters behind the action, served as corpsmen with the mission of rescuing the wounded during battles. They were paid for each casualty they rescued. No similar formal evacuation system existed in Western Europe until the late 18th century.

Prior to the Napoleonic wars of the late 18th century, there was limited interest in evacuation for many reasons. The primary reason was that generally, any casualty who needed care beyond that of what today we would consider first aid was probably not ever going to return to duty—medical care of the period simply was not able to offer much hope for treatment or cure. “Natural triage” decided which casualties would receive care and which would not. Wounded soldiers who did live were simply a hindrance to future operations of the Army, and in some states were costly, due to war pensions or payments required, which often were not paid to the relatives of those killed in combat. Further, evacuation of the wounded required that other combatants be removed from the fight to provide their transport, or tied up transport needed for other military functions. To an extent, the ability to move patients from the battlefield developed much more slowly than did other medical capabilities in the 18th century armies—evacuation was not generally believed to be a medical responsibility, and in general the surgeons cared only for those who could be brought to their facilities by others, or who could get there on their own.

As medical capabilities increased, as in Napoleon’s medical services under the leadership of his surgeon Baron Dominique-Jean Larrey, a growing interest developed in decreasing the time between wounding

and surgery. When he took his position as Surgeon-Major of the Army of the Rhine, Larrey noted that the “wounded were left on the field, until after the engagement, and were then collected at a convenient spot, to which the {field hospitals} repaired as speedily as possible.” He soon realised that “most of the wounded died from want of assistance”. This recognition led to his development of the “Flying Ambulance”, which as originally designed was a light wagon used to take surgeons forward to the casualties, rather than the reverse. However, in his later years, Larrey developed these “ambulances volantes” into patient-carrying vehicles, which actually had provisions for enroute care, and thus engendered the beginning of true patient evacuation systems. By the time of the Italian campaign, Larrey had organised and equipped three divisions of ambulance services, complete with evacuation vehicles, trained personnel, and equipment. He further developed his ambulance service in the Egyptian, Syrian, and Polish campaigns, with great success. Unfortunately, most other armies did not learn adequately from Larrey—while they began to develop evacuation systems, in most cases they were inadequately staffed and equipped to be usable. Such personnel as were made available for casualty movement were generally detailed from the line rather than belonging to the medical services, and adequate appropriate vehicles for this mission were rare.

By the middle 1800s, most Armies had developed some sort of evacuation system. They often proved totally inadequate to the task, as they did at Waterloo, Gettysburg, and the Crimea, but at least they were beginning to be seen as important and as a medical responsibility. They were, as today, often characterised by “ad hoc” improvisation, and rarely used any vehicles which belonged to the medical service. Even the limited numbers of “medical” vehicles were normally little different from those used by non-medical units. The failures of the American Civil War and the Crimean War, coupled with the increasing “humanitarianism” of the age, led to a demand for better medical care for the wounded, as organised by Jonathan Letterman, Clara Barton, Florence Nightingale, Henri Dunant, and Nikolai Pirogov.

As organised evacuation became more common in the late 19th century, and as military medicine improved its capabilities, commanders began to see that there were distinct advantages to organised systems of evacuation. No longer did evacuation of a casualty necessarily demand that other combat troops leave the combat zone to move him; morale improved among troops, since they believed they would receive improved care if wounded; and the survival rate among wounded soldiers improved dramatically.

Every draft animal ever used by an Army has been pressed into evacuation service, as has nearly every type of vehicle. As each new vehicle has become generally available, it has been adapted to medical use. Horsedrawn wagons were gradually replaced by trains and motor vehicles, which have since been supplemented by aircraft. Until after WWI, however, one thing was sorely lacking--- routine medical care en route. Gradually, throughout WWII and until our era, care en route has improved, patient survival has increased, and the logistics burden on the forward commander has been reduced through his improved ability to move casualties rearward rather than medical support forward.

Most of the mechanisms of patient evacuation, particularly those which are man- or animal-powered, have evolved very little since the dawn of time. Most casualties in “big” wars, or in conflicts in the third world, still receive transportation support which is indistinguishable from that of centuries past. Man-carried and animal-powered evacuation continue to be used in various parts of the world, and will probably always play a major role in the combat zone—unfortunately, generally speaking these will always provide simply transport, with little care enroute being possible.

During and since the Second World War, there has been increased emphasis on using evacuation to actually benefit the patient during transport, rather than seeing it simply as another form of “cargo hauling”. This requires specialised equipment and trained transport personnel. We see this development today primarily in some well-equipped ground vehicles and in some aircraft. In a large war, it is unlikely that any nation can afford to provide each casualty with modern intensive-care level care during transportation, and in such circumstances we will probably fall back on less-capable transport means. However, in peace-keeping or crisis response operations, in which fewer casualties are expected, our nations may demand that each and every patient receives the highest possible level of care. This demand

is now NATO policy, in that MC 326/1 demands that “even in crisis or conflict, the aim is to provide a standard of medical care as close as possible to prevailing peacetime medical standards.” This demand on the part of our nations will mandate ever-increasing reliance upon state-of-the-art evacuation capabilities for the foreseeable future. No longer will the empty truck or the empty helicopter, without medical care of the highest level on board, be considered as providing an acceptable level of care.

One of the most-used forms of patient transportation today is aircraft. The development of this form of evacuation from a dream to a reality reflects in a microcosm the development of patient evacuation in general. For the next little while, I would like to review with you the history and development of air evacuation, and point out some of the lessons learned in the past, its capabilities for the future, and its role in the new multinational medical support concepts of NATO.

The history and development of the capability to provide in-flight medical care closely parallel both the history of flight itself and that of medical technology. From the earliest days of flight, Physicians have been trying to use aircraft in the care of their patients, and it may be useful to review the development of this modality.

The history of aeromedical operations can be generally divided into four eras:

- Period up to 1920—Theory and “heroic experiments” (conception and pregnancy)
- 1920-1939—intermittent interest and development of systems (infancy)
- 1940-1960—growth and development of systems—patient as “cargo” (adolescence)
- 1961-present—full acceptance, rapid growth, increased technology—patient as “patient” (Adulthood)

Conception and Pregnancy--

Although aeromedical evacuation has been most recently brought to public attention as a result of its massive use during the War in Viet-Nam and the preparations for its massive use during Desert Storm, it is not a new concept. In fact, the concept of aeromedical transportation pre-dates even the first heavier-than-air powered flight by the Wright brothers in 1903. As early as March 1784, following the balloon flight demonstrations of the Montgolfier brothers before the medical faculty of Montpellier, physicians began to consider the benefits their patients could gain from flight. They early theorised that, not only could sick patients tolerate flight, but that they would in fact benefit from “the purer air encountered at altitude”. So far as I can determine, no practical use was ever made of the concept of balloon evacuation. It has been reported many times that in 1870, during the Prussian siege of Paris, over 160 sick and wounded patients were evacuated by means of balloons. Having investigated this situation in great detail, I can inform you with assurance that no such patient evacuations ever took place during the siege of Paris.

Between 1892 and 1910, the innovative Surgeon General of the Dutch Army, General De Mooy, developed an entire concept for medical evacuation, including ground vehicles, aircraft, dirigibles, and captive balloons pulled by horses. Unfortunately, this forward-looking concept, which gained him the sobriquet of “the Jules Verne of aviation medicine”, was never tested nor implemented.

The first great step forward in the concept of aeromedical evacuation occurred in 1909, when Captain George Gossman, a U.S. Army medical officer, joined with Lieutenant Albert Rhodes of the Coast Artillery Corps in designing and building an aircraft specifically for the transportation of patients. The aircraft, though crude and requiring the patient to lie unprotected on the wing alongside the pilot, was successfully flown (once!); and Gossmann and Rhodes attempted to convince the War Department to develop the concept further. Since this proposal was made only a year after the Army purchased its first motor-driven ground ambulance, and in the same year in which the Army purchased its first aircraft (it was not to purchase another for two years), it may be imagined with what degree of success they met. In the face of War Department obstinance, numerous medical officers took up the battle for air evacuation. The response of the War Department echoed that of the newspaper, the Baltimore Sun, which proclaimed that “the hazard of being severely wounded was sufficient without the additional hazard of transportation by airplane.”

In France, too, military medical professionals faced opposition from the Ministry of War in attempting to develop an air evacuation capability, but the opposition of the conservatives was to be overridden by the force of circumstances. In November of 1915, during the retreat of the Serbian Army from Albania, it became impossible to evacuate all the sick and wounded of the French Expeditionary Force by ground means, and it was unthinkable to abandon the wounded to capture. Therefore, although the only available aircraft were fighter aircraft in poor condition, the decision was made to attempt evacuation by air. The first heavier-than-air evacuation in history took place on 15 November 1915, and over the succeeding month, 13 wounded were evacuated from front-line, poorly-prepared airstrips, often within rifle shot of the enemy. Based on this dramatic evidence of the usefulness of air evacuation, as well as on the results of exercise trials, the French Government authorised the development of the first air ambulances, which were first used in combat on the Aisne front in 1917. However, the risk of aircraft losses derailed this experiment, with one member of the Chamber of Deputies crying “Are there not enough dead in France today without killing our wounded in airplanes?”

The United States, in gearing up for entry into WWI, developed numerous new flying fields. These fields were established in areas of the country with poor roads, and it was often a matter of several hours before a student pilot injured in a crash could be brought to a hospital. Flight Surgeons rapidly began to develop air ambulance conversions of the JN-4 “Jenny” training aircraft, and by 1919 such ambulances were a fixture on all training fields.

By the end of WWI, air ambulances were in common use in the United States, and had seen limited combat use in France. No other nation actually used air evacuation, though the United Kingdom had experimented with it before the war. However, neither medical systems nor the airframes themselves were able to allow in-flight medical care. Though built in numerous versions, each of these early air ambulances had one common feature—the patient was enclosed in the fuselage, without an attendant, and with no possibility for care in flight. In this regard, they were the model for most air ambulances during this period. Even though the air ambulance was a reality, it was seen only as a means of transportation, rather than as an integrated part of the medical care system.

Infancy--

Although air ambulances were certainly in increasing use following WWI, there did not appear to be any great need for systematic air evacuation on a large scale during peacetime. Most nations paid little attention to the issue, though military air evacuation systems were developed by France and Britain for use in their colonial wars, and successfully evacuated thousands of casualties. For the first time, there was an effort to provide some limited in-flight care, and one Breguet XIV-b Limousine was described as having “electric boilers, coverlets, tank of oxygen, surgical instruments, and dressings”. For the first time, aircraft were integrated into the military medical system, even though still under command of non-medical officers. The benefits were clearly recognised, but unfortunately the systemic changes needed in military medical establishments to make optimum use of this new modality were not adopted by most nations.

Beginning in 1920, the U.S. Army developed an ambulance modification of the Dehavilland DH-4, which was produced in significant numbers, and several of which were used extensively on the Mexican border. Just as had been the case with earlier air ambulances, these planes carried their patients isolated in coffin-like enclosures built into the fuselage. As these planes became obsolete, the Army began to experiment with various types of air ambulances, most of which were produced in only one copy for experimental purposes. Some of these, notably the Curtis Eagle, provided adequate space inside so that a physician could accompany the patient and could (at least theoretically) provide some care in flight. In 1930, the Ford Trimotor of the U.S. army was described as the “largest and most complete airplane ambulance ever designed”. It carried a physician and medical technician, who had access to various instruments, drugs, splints, and dressings. However, during the money-tight 1930s, the United States was unable to really create an air ambulance service, and official interest in the concept was nearly non-existent.

This interest on the part of medical professionals was not restricted only to the United States, France, and the United Kingdom. During the 1930s, most aircraft manufacturers in Europe produced at least one

ambulance version, and soon there appeared ambulance versions of amphibians, flying boats, “touring airplanes”, and float planes, in addition to the normal military aircraft of the day. Both military and civilian versions were produced, with significant civilian use being made of them in countries with large, sparsely-populated, regions such as Sweden, Thailand, and Russia. The most comprehensive civil system was probably that of Russia, while France and Germany developed probably the world’s most extensive military systems prior to WWII, with France even fielding squadrons of small aircraft with built-in patient oxygen (though they still could provide no in-flight care capability). The Germans developed an extensive system of evacuation during the Spanish Civil War, by which casualties from the German Condor Legion were evacuated over the Alps, covering distances of up to 1600 miles at altitudes of up to 18,000 feet in unpressurised JU-52 aircraft. Only minimal care beyond oxygen and dressing changes was available in-flight.

Adolescence--

During WWII, necessity dictated the development of a world-wide air evacuation policy for both sides. The Germans had an extensive military evacuation system established at the time of the onset of war with Poland, and by August of 1941 they had evacuated over 280,000 casualties. The Russians used air ambulances extensively during the Winter War with Finland, though again only minimal care enroute was possible—their larger aircraft carried only Oxygen as a treatment modality, along with hot water bottles and blankets. Some of their evacuations were even more basic, reverting to the concepts of patients as cargo—they actually carried patients in enclosed pods mounted on, or hanging under, the wings of their PO-2 and U-2 aircraft. However, the massive distances involved in this war rapidly led to a heavy reliance on air evacuation in all theatres. From the time of the early Japanese successes in Southeast Asia to the end of the war, over 1.2 million patients were evacuated by U.S. Aircraft alone, utilising standard cargo aircraft, usually without medical support. Patients were no longer restricted by injury type, and in fact all types of casualties were moved. Care in flight began to be developed, and by the middle of the war included injections, transfusions, pleural fluid or air aspirations, and tracheal care. Long range aeromedical evacuation had become a reality.

Ad hoc innovation was common. One prime example of the innovations developed in the realm of air evacuation took place in June 1944 when an officer in Western China developed Respiratory Polio. He survived 14 days of artificial ventilation, while an airstrip was built. A homemade respirator was designed, and he was flown out in a small aircraft, with the patient himself pumping the chest compression pump as he rode. Subsequently, he was flown “over the hump” to India in a C-47 with an iron lung.

Although the major form of air evacuation during WWII was long range, what we now call theatre or strategic, it must be realised that another form of air evacuation was also in use. While there were continuing efforts to improve the amount and quality of care which could be given in flight during the long-range flights, there was a realisation that other flights from the forward areas to medical facilities to the rear were still needed, even if care in flight was not available. Accordingly, small aircraft were routinely used on a regular basis by all the belligerents, and helicopters began their career as lifesavers, though on a very limited basis.

First used to evacuate casualties from isolated patrols in Burma, the helicopters soon developed a reputation as lifesavers, and new models were rapidly developed. Used by the French in Indochina after WWII, by the British in Malaysia, and by the UN forces in Korea, helicopters rapidly took over the role of short-range evacuation from the small fixed wing aircraft. Although only very limited care was available in flight (IVs including plasma, inserted prior to flight), the helicopter became a mainstay of military medical services.

Continued development was the norm after the Korean War. For example, in 1954, the U.S. C-131 was produced in series, the first specifically-designed fixed wing air ambulance with modern technology. It was not only pressurised, but air conditioned, and was designed to routinely carry major medical life support equipment such as iron lungs.

Looking back, we are forced to observe that the record of air evacuation in WWII and the Korean War, though a proud one, is not the product of such imagination, development, and forward planning as one expects of the air age. The most persistent experimenter was “necessity”, faithfully providing again and again situations in which air was the only or the best means of evacuation.

Adulthood--

The shortcomings of the early helicopters were recognised as a result of their use in Indochina, Malaysia, and Korea, and soon after the Korean War a design competition was held to choose a new U.S. Army helicopter ambulance. The winner of the competition, the Bell XH-40, later to be called the HU1 “Huey”, was built to medical department specifications, and became the most successful helicopter ambulance to date. With the development of the Huey, along with organisational and operational changes made between the wars, the U.S. Army was well-prepared to carry out forward air evacuation missions during the War in Viet-Nam. For the first time in the history of warfare, there was an extremely good chance that a soldier wounded in battle could be receiving specialised medical care within one to two hours of being wounded. Specially trained medical corpsmen were used on these aircraft, and contributed greatly to the success of the mission, starting IVs, stopping bleeding, maintaining airways, and occasionally even doing life-saving surgery such as cricothyroidotomies. As a result, of those evacuated who lived to reach a medical facility, about 98% survived, hospital stays were reduced, and the overall risk of dying in combat if wounded was reduced to less than ½ of the risk during WWII. At the same time that the Army was carrying out its forward mission of air evacuation, the U.S. Air Force re-activated its massive inter-theatre airlift of WWII and Korea, moving hundreds of thousands of troops out of Southeast Asia to Japan, the Philippines, and to the United States. Of great importance was the inclusion on the crews of flight nurses and medical technicians who were able to carry out increased levels of medical care and monitoring in flight.

Throughout this period, we have seen continuous improvement in the medical capabilities found on air ambulances. In the 1960s, aircraft routinely carried stryker frames and respirators. Emerson pleural drainage pumps and closed water seal drainage became the norm. Intermittent positive pressure breathing devices were flown routinely, as were the then-new Baby Bird Respirators. In the 1970s, air ambulances began to routinely carry neonatal transport units, physiologic monitoring equipment, defibrillators, and IV pumps. By 1973, Belgium had Aerospatiale Pumas with sophisticated medical equipment for intubation, suction, drainage, probing, cardiac infarction monitoring, defibrillation, etc. In the 1980s, it became nearly routine to fly with Intraaortic balloon pumps and doppler blood pressure measuring devices. Portable hyperbaric chambers have been routinely flown since the late 1980s. This rapid infusion of medical technology into the air environment does not show any sign of slowing down. There is now only a lag time of 4-5 years between introduction of a piece of equipment into the hospitals before it appears in the air, and that appears to be decreasing. Today, almost any piece of equipment short of an MRI has been put into an aircraft, and we have finally reached the capability of the true flying Intensive Care Unit.

All in all, it is in this period during which air evacuation has really come of age. We are now truly able to say “Patients are not cargo; patients are not passengers; patients are patients.”

CONCLUSION:

Operations during Desert Storm demonstrated that the old concept of having large medical facilities forward which could provide definitive surgery on all patients and hold them until they were “stable” was no longer viable. It became evident that the movement of more “stabilised” or “unstable” patients would become the norm, and most of the major nations have now implemented systems to ensure the provision of more highly-trained medical aircrews and more “intensive care unit”-like equipment in both fixed and rotary wing ambulances. Of interest is the fact that the civilians seem to be leading this move. With a few outliers, such as the ability to move highly infectious patients in P4 containment, the civilians are leading the way in acute care in the airborne environment. Many of our university hospitals have developed air

ambulances with capabilities far in advance of those of our military services, and we in the military are only now starting to catch up.

The transformation of the security environment in Europe has had a profound effect on the North Atlantic Alliance. Major reductions in the levels of armed forces, combined with the acceptance of new or expanding tasks (such as IFOR, SFOR, and KFOR) have presented significant new challenges to NATO's medical staffs. On the one hand, "peacetime level" quality of care is demanded, while on the other hand, there is a demand for decreased deployments of increasingly scarce medical resources. Thus, the concept of putting large medical establishments on the ground in the forward area is rapidly losing favor, in light of improved evacuation systems. In the near future, we envision that the majority of evacuation will be by means of multinational aeromedical evacuation, a concept for which is included in AJP 4.10, which is currently out for national ratification.

Present evacuation trends indicate that both air and ground ambulances will serve in the battle areas of the future, but the increased depth, width, and complexity of the operational areas indicates a recurring need for both lateral and rearward movement. It therefore becomes obvious that, so long as air supremacy can be maintained, the bulk of the workload will be via airlift, rather than via ground means, especially in Crisis Response or Peacekeeping Operations.

Improved medical care capabilities being placed in the American UH-60Q model Blackhawk helicopter, the critical care transport teams of several nations, and such new items of equipment as the portable intensive care unit called LSTAT (Life Support For Trauma and Transport) unit are only now being fielded. Some nations have developed intensive care "boxes" which can be placed in certain types of commercial aircraft, but unfortunately these are available in very limited quantities, and can provide care for relatively few patients. Unfortunately, development in this field is very uneven, with some nations being far ahead of others, some of which are still in the WWII era as far as quality of in-flight care is concerned. We at NATO are devoting much effort to development of standardisation documents which will enhance interoperability of national air ambulance systems, and which will eventually lead to truly multinational capabilities in this arena. To date, we have such agreements covering litter specifications, on-board medical equipment, medical crew training and staffing, and administrative requirements. Others are currently in development.

For the farther future, who knows what evacuation means will be used? I suspect we will see, in not too many years, the first use of a space shuttle to evacuate a casualty from the international space station. It is doubtful that such an evacuation could rightfully be termed "air evacuation", but it certainly would be a direct descendent of the concepts and capabilities in evacuation developed over the past several hundred years. I for one am looking forward to seeing that.

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